

HABITS OF THE SAND-WASP.

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North-west Victoria is particularly rich in wasps and other insects of the order Hymenoptera. The genial climate of this sunny corner of the State is, no doubt, the main cause of their presence in such numbers and variety. Wasps, though fascinating insects, have had little attention paid to them in Australia.

With the object of interesting especially the younger members of the Club, I shall describe the habits of the wasp, *Ammophila suspiciosa*. My notes, by no means complete, for they have been gathered in moments stolen from pressing work, may serve as an introduction to the study of the species. *Ammophila* means "lover of the sand." It is a title euphonious and well applied; though perhaps almost any species of wasp that burrows in this region could, with justice, bear the same name.

The Sand-Wasp, like most wasps that dig a perpendicular burrow, prefers a firm soil in which to begin its excavating, and the beaten paths used by man, and the head-lands in a vineyard, are much favoured by it. The loose, sandy soil of the vineyard itself, is one of its favourite hunting grounds. And as its prey is invariably a caterpillar of the Bogong Moth, *Agrotis spina*, or allied species, known to the man on the land as "cutworms," it is obvious that the wasp is of economic importance. About September, when the vines are beginning to shoot, the cut-worm pest, especially in a newly-planted vineyard, frequently assumes serious proportions; and were it not for the effective check kept upon these caterpillars by certain species of birds and insects, the lot of the grower would be unbearable. The same applies, but with even greater force, to the wheat-grower, for, unlike the horticulturist, he cannot protect himself by the application of poison-baits and sprays.

The "balance of Nature" is very wonderful, and almost simultaneously with the appearance of the cut-worm cater-

pillars *Ammophila* leaves her winter's prison in the ground as a perfect insect. Perfect, that is, in all but wing-development; and very soon the tiny, double wings become expanded to their full size. Love-making over, the wasp, between visits to flowers in search of nectar, applies herself to the capture and paralysis of cut-worms, and the perpetuation of her race. Should the day be cold and cloudy, her activities as a huntress are temporarily checked, for, like butterflies, wasps are lovers of sunlight. At night they take shelter in post-holes and hollow trees, and, on cold mornings, remain concealed until the sun tempts them forth.

The cut-worm larva is a night-feeder, and before daylight it burrows into the soil, perhaps a quarter or half an inch below the surface. In a vineyard the horticulturist can often note its presence by the disturbed condition of the soil; but the wasp apparently finds it by some other method, in which her antennæ play an important part.

When hunting, the course of the wasp, to an onlooker, appears to be very erratic. In her wanderings often she goes over the same area again and again. With antennæ tapping the ground, she pauses, burrows, moves on, burrows again; and so the hunt continues—sometimes fruitlessly if the game be scarce—for half an hour or more. It seems fairly certain that where she burrows a cut-worm has been concealed, or is then in hiding, but probably at too great a depth for her to make a successful capture. So far, I have failed to find a cut-worm at such places, but with other species of wasps, particularly a small member of the genus *Pompilius*, a spider huntress, I have had sufficient proof to convince me that the wasp has a sure method of locating her hidden prey. It is probable that the insect is endowed with a sense of which we have no knowledge. Those delicate, waving antennæ surely hold the secret that baffles my understanding!

The presence of her prey can hardly be detected by the wasp by sound, unless her organs of hearing are extremely delicate, for the cut-worm lies perfectly still. On the other hand, it is doubtful whether scent is the determining factor. Time and again, I have placed a cut-worm in the path of a wasp intent on hunting, and she has passed within a few inches, or walked right across it. On the surface of the soil, and quiescent, the caterpillar was merely an obstruction in her path. Had it moved she might have recognised it as her usual game. If smell were the deciding sense, she would have immediately seized and paralysed the cut-worm when

walking across its body. That she did not recognise her prey by sight alone is not strange. The sight of a wasp for *still* objects is not particularly good, and, moreover, her instinct tells her to seek for the cut-worm beneath the soil. The soil in conjunction with the antennae acts as a medium whereby the presence of her quarry is transmitted to the wasp's brain, but in what way I do not know.

Ammophila suspiciosa is a solitary species. Provided that the soil is firm enough to burrow into, her wants for the site of the home for her grub are satisfied. She first captures and paralyzes her game, and then, within a few yards, excavates a perpendicular burrow about an inch and a half in depth. Branching off at the bottom is a cell just large enough to accommodate the caterpillar. The varying methods adopted by individual members of the species from the time when the caterpillar is captured until the burrow is finally closed are somewhat remarkable. When I first observed these variations, I thought, maybe, I had met with two distinct species, but a close examination revealed the wasps to be identical.

In this variation of habits, there is one outstanding feature. In one case the wasp, after she has paralyzed her prey, places it off the ground, on vegetation, while she constructs the burrow for its reception; in the other case, she buries it temporarily by raking sand over it with her forefeet. I have had no evidence as yet to show that the one individual is capable of adopting either method according to her fancy, and, unfortunately, I have not had the necessary time to devote to continuous observation and experiment, whereby this point might be settled. It is certainly full of delightful possibilities, as it would go a long way towards proving whether the wasp is bound rigidly in her actions by instinct, or whether she is guided to a limited extent by reason.

Quoting from my note-book, I will deal, first, with the case of a wasp that temporarily buries its prey:—

8/11/24.—“About 4.30 p.m. I noticed cut-worm wasp digging a burrow. She was bringing up pellets of earth supported between her mandibles and front legs, and as she reached the top of the burrow, walking backwards, she would throw the earth behind her with a quick action, and immediately go below again. As the burrow neared completion, it took her from four to seven seconds per trip. Several times she left her task, and took aimless walks around the neighbourhood pausing occasionally to sun and groom

herself. On returning to the burrow she exhibited signs of nervousness, and seemed afraid to go below. I was puzzled by these actions until I observed a small, brown ant near the entrance to the burrow. The wasp was very scared of the tiny ant, and jumped into the air when she saw it at close quarters. The same thing happened when she blundered across a line of ants in her wandering. Finally, she came back to the burrow, made several attempts to go below, hesitated, descended about half the length of her own body, and backed out and resumed her wandering. I was surprised when she stopped at a small heap of sand an inch from the burrow, and, after scratching, a paralysed cut-worm lay revealed. This was my first glimpse of this procedure, for previous wasps that I had studied had placed their game on vegetation.

"Seizing the cut-worm by the body near the head, and clasping it belly to belly with the aid of her front legs, she carried it to a distance of about four yards. Placing it on the ground, she again raked sand over it with her fore-feet, and after more wandering she returned and began a burrow two inches away. I accidentally disturbed her, and she began on another. After ten minutes' work she abandoned this also, as apparently not to her liking—perhaps a root had interfered with her work—and resumed her wandering. A fussy, particular wasp, this! In a few more minutes she picked another spot, two feet from caterpillar, and energetically set to work. The mandibles and fore-feet are used in conjunction, the feet—unlike a dog, that scratches the earth back one foot at the time—being operated together.

"As she bit at the earth she hummed, but the humming ceased as she backed with her load or swept it away with her feet. Three times during the excavation, which occupied half an hour, she carefully groomed the moist sand from her face, body, legs and antennæ. In her endeavour to clean her hind-legs she frequently overbalanced and fell on her back, owing to her legs becoming temporarily entangled. Her middle pair of legs are cleaned independently by the front pair; likewise the face and antennæ. Balancing on the front pair of legs, and one middle—usually the right middle—the hind pair of legs, together, would be rubbed up and down on the free middle leg, and to gain additional balance the wasp often put its head on the ground. It was while engaged in cleaning this back pair of legs that the interlocking of the joints happened, and caused the upsetting of her equilibrium.

"During these grooming operations she wandered within

a radius of several feet from the burrow, and at times scratched more sand over her capture. The moist sand adhering to her annoyed her like water sometimes annoys a dog. As the dog rubs itself on the grass to remove the water, so the wasp rubbed herself against the dry, surface sand, with the object of removing the moist sand. When sunning herself, she kept her body flat on the ground, and the middle pair of legs, and frequently all the legs were held at an angle above the body.

"At twenty minutes from the time of beginning the burrow, she gave herself the second complete cleaning; and, after a brief wander, came to the caterpillar, partly uncovered it as though to assure herself that it was still there, and then covered it again with sand. Returning to the burrow, she brought a few more loads of earth from below. All the earth was deposited on the one side, and, unlike many members of her species, she did not trouble to rake the pile backward to clear a space for further deposits. Consequently, as she descended, she occasionally took as much down as she brought to the top. However, the job was eventually completed to her satisfaction, and, after another grooming she spread her legs at an angle above her body, and, except for a continual movement of the abdomen in and out, lay motionless, resting and enjoying the sun.

"Suddenly she went to the cut-worm, deftly uncovered it, and, seizing it in the same position as before, she transported it to the burrow. A little manœuvring to place the head in position over the burrow, and she squeezed past and descended, head first, to the bottom. In a few seconds she ascended, for the first time, head first, and, grasping the paralysed creature by the head, pulled it below. A minute passed, and she had arranged the provender in the desired position, laid an egg upon it, and ascended to the surface. A small quantity of earth was swept backward into the hole, and she descended to push it into position with her head. This procedure continued until the burrow was almost full when she selected small pebbles and bits of chips, and placed them, one by one, into the hole, raking further loose earth, between the trips, with the larger fragments. Several times, while holding a small chip in her mandibles, she pressed the soil into position, often picking up the same piece or using another bit that happened to be closer. A final sweeping of about two inches from all sides of the burrow, and the job was finished. All traces of the burrow had disappeared, and the wasp, retiring a few feet, again completed her toilet before flying away."

The most interesting fact about this observation is, that the wasp is, in reality, an implement-user.

The Peckhams, in their admirable work on American wasps ("Wasps, Social and Solitary"), describe how *Ammophila urnaria* uses a stone to pound down earth over her nest-burrow: "She improvised a tool and made intelligent use of it."

There is a considerable difference in the methods of wasps at work. Some are particularly fussy about their toilet, and often excavate several burrows before they are satisfied with the conditions. Their dread of ants, which frequently raid their game at the unguarded moment when it is lying exposed, is often responsible for this, and some resent the intrusion of a human being. The ants, once they have a good grip on the leg of a wasp, are hard to dislodge, and the wasp has probably had experience on this point. Other specimens I have noted are very thorough in their work, taking care to sweep the soil well back from the burrow, so that there is ample room for fresh deposits. Of their toilet they take little heed; the work in hand is all-absorbing for the moment; and all their movements are methodical and thorough.

It seems strange, on first thought, that wasps should be so particular in the choice of their game. Nearly every order of insects, and also spiders, appears to have its own special wasp enemy. If there is any variation at all as regards the kind of insect captured, it will be found, in most cases, to be a species closely allied to that generally favoured. The reason for this is apparent, when we consider the hunting methods of the wasp, and particularly her manner of paralyzing her prey.

Describing the nervous system of an insect in his book, "Insects: Their Life Histories and Habits," my friend, Harold Bastin, says:—"Beneath the digestive canal (not above it, as in the case of vertebrate animals) passes the central nervous chain of the insect. This is composed of twin cords which connect a series of paired knobs called ganglia. Roughly speaking, each pair of ganglia may be likened to a minor brain, which governs the activities of the parts that immediately surround it. This arrangement accounts for the curious disconnectedness of action, which is observable in a maimed insect." By her marvellous instinct the wasp has a full knowledge of the vital nerve-centres of her game, but apparently only within the limited range of a genus, wherein the nervous system is more or less identical.

This explains why her choice in selection is limited to certain species.

In some insects, owing to the grouping of the ganglia being close together, one stab is sufficient to cause paralysis. The slayer of such an insect, if faced with the problem of reducing a cut-worm to a stage of helplessness, where the prey has to be stung in several nerve-centres in succession, would have no knowledge of how to proceed. Her art in the use of the sting, so perfect and uncanny in its application, is highly specialised, and therefore limited in scope. But let me proceed with the method of the *Ammophila*, and the variations that accompany that method.

The actual paralysis of the victim is produced in two distinct operations. But first there is the digging out of the cut-worm. Having located its position, the wasp sets to work, in frenzied haste, biting and pulling at the soil, and roots of grass, etc., that obstruct, and throwing the soil behind her in a shower. First on one side, then on the other, she digs, without pause, until the cut-worm lies exposed. Then, without a moment's hesitation, she seizes the writhing creature near the head, and, curving her abdomen, plunges the sting between the first and second pair of legs. Now, withdrawing her sting, and bending her body a little more, she attacks the first segment near the base of the mouth. The cut-worm is now at her mercy. It can still wriggle the hind portion of its body, but it cannot move from the spot. The wasp, as though realising this, leaves it for a while, and arranges her toilet. In the struggle, and hasty digging, she has numerous grains of sand adhering to her; and, as described earlier, she has certain ways of removing the annoyance.

Fabre, who has explained the habits of French wasps so lucidly, considers that the rolling about of the *Ammophila*, after the close of the first act in the paralysis of her victim, is, in effect, "a manifestation of delight" in the conquest. I cannot agree with this, for I have seen the same manoeuvre when the wasp was merely engaged in cleaning herself. As stated previously, it is simply an interlocking of the joints of her hind and middle legs, and this upsets her balance. Her toilet completed, she again mounts the cut-worm and stings it between the second and third pair of legs; moving a little, she takes a fresh grip with her mandibles, and stings it in the next segment. Still another movement backward, and the sting is inserted between the first and second pair of pro-legs. Sometimes only four nerve-centres are attacked, never more than five, according to my observations. As to

the exact points attacked, I find that I have the above positions stated in three places in my note-book, but on account of the sting being thrust underneath the caterpillar it is difficult to determine the exact spot where it enters.

The paralysis complete, the wasp gently squeezes with her mandibles near the head of the game, sometimes from above, sometimes laterally. This action causes sickness in the cut-worm, and for several minutes the wasp eagerly laps up the juices with her tongue. I have observed a wasp, on returning to the leaf where she had placed her game, and, finding it not quite paralysed to her fancy, again sting it in a few places. One wasp began at the anterior end, but, seeming to realise her mistake, she turned around, and attacked it in the orthodox manner.

That some wasps are less skilful than others is evident. I have kept numerous paralysed caterpillars to determine the period of hatching of wasps' eggs, the method of feeding of young wasp, etc. In one case the stung creature partly revived, and, turning completely over, detached and damaged the egg. In another instance the young wasp hatched, and began its meal; but it was obvious that the provender was dead. In two days the young wasp was also dead, poisoned by the decomposing food. This is the only note I have where the wasp had made such a fatal mistake. I did not observe the stinging in this case, so that I am unable to account for the blunder.

In order to determine whether the wasp is capable of reasoning, I have conducted certain experiments. A record of these, and an account of the development of the wasp-grub to the adult stage, etc., may be given in a future article. My thanks are due to Mr. F. E. Wilson for identifying specimens of wasps that I have forwarded to him.

EXCURSION TO MOUNT MORTON, BELGRAVE.

Four members took part in the excursion to Mount Morton on 18th August. We followed the pathway from the east end of Belgrave station, by which the road journey to South Belgrave is shortened to the extent of about a mile. This pathway passes the recreation reserve, and leads on to the recently deviated Country Roads Board road to the bridge over